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COKE MANUFACTURERS IN OHIO.

BY THOMAS B. BANCROFT.

In presenting this paper to the Institute I am convinced of its deficiencies. My intention was to have presented an article treating of the adaptability of certain of our Ohio coals for coking, as well as upon the process, or method of their treatment adapted to secure the best results from them. I had expected to have drawn deductions covering these points, from the experience of those who had been engaged in the business and from whom details and facts could be obtained relative to their efforts.

In this, however, I was met with the fact that all coking in Ohio, with one or two exceptions, is a thing of the past, and the parties interested in, or having charge of the operations, were not to be found, or if found, spoke only from memory and were possessed of no data from which any conclusions could be drawn or opinions sustained. The only analysis of Ohio cokes that were obtainable were those of Leetonia and the Jefferson Iron Works, of Steubenville. With the exception of the operations at Zanesville and Vinton Furnace, beehive ovens only have been used, and the result in every instance, with these ovens, has been a friable coke. Most of the attempts at coking in the state have been made with the coals from veins No. 6 and 7, and have followed one beaten track, offering no opportunity to decide whether any better method could have been adopted for coking them, or whether other other veins might not have been more profitably em-

ployed. With these difficulties in view, and with the meagre details at hand, it was decided, as the only resource left, to make the present paper simply a condensed history of coke manufacture in Ohio, and it is hoped even in this dry form it may not be found altogether uninteresting.

It may be laid down as an axiom that ALL Ohio cokes are friable and do not bear transportation. It may also be said that experience has shown that veins No. 6 and 7 are the best adapted for coking, where improved ovens and machinery are not used in the process; and that those of the Ohio coals that cement well in coke, contain too much sulphur, while those that are free from sulphur have not sufficient bitumen to cement them, either of which deficiencies render a coke of but little value in a blast furnace.

The largest continued coking operations in the state are those at Leetonia and at Steubenville, at both of which places coke is now being made, though with a greatly reduced product. In fact the only coking now being done in the state is at these two points and near Bridgeport, on the C. L. & W. R. R.

The most thorough and systematic attempts to solve the problem of coking the Ohio coals have been made at Zanesville, and at Vinton Furnace, in Vinton county. The Belgian ovens erected at Zanesville; in 1874, have all been demolished, but those at Vinton Furnace are still standing. Reference will be made to the operations at these two points, further on.

The earliest effort at coking in Ohio appears to have been made at Leetonia, in the year 1840.

Parties there made coke from the Lower Kittanning coal. This coke was hauled in wagons to Salem and Massillon and was used in foundry cupolas.

About 1850, coke was made near Youngstown, in bee-hive ovens, from the block coal. It is said of this coke that it came out of the ovens as coke in the same shape that it went in as coal. This would indicate that, like some other coals of the state, it lacked bitumen to fuse or cement it into a common mass. The coke was used for foundry purposes, but the effort to obtain more full and definite details of the experiment, has been defeated by inability to find any of those connected with the venture.

COKE MAKING IN COLUMBIANA COUNTY.

As before remarked the earliest coking operations in the state occurred in Columbiana county, and considerable has since been done at different points throughout the county. At East Palestine and Salineville coking has been carried on to some extent for a number of years. The most extensive operations, however, have been at Leetonia, where Messrs Young and Chamberlain began coking the coal of No. 4, or the Lower Kittanning, in 1857. From this beginning came the present coking operations of the Cherry Valley Iron Works. The lower portion of the vein, only, is used for coking and the product is used in the furnaces of the company. Bee-hive ovens are used but in this case, as in every other instance in the state, the amount of coke made, and the number of ovens in use has gradually decreased. This coke is softer than Connellsville, and does not bear transportation, but is high in carbon, and very low in sulphur and

ash. It is said to bear a burden well in a furnace, and to work very satisfactorily with the native ores. These ovens, while reduced in number, are the only ones now working in the state for the purpose of making coke for use in a blast furnace.

COKE MAKING IN JEFFERSON COUNTY.

About 1855 the Hammondsville Mining Co. began the manufacture of coke, at Hammondsville, in a few bee-hive ovens, of ordinary size and form, which they subsequently increased in number to about twenty. These ovens were run to their full capacity until the breaking out of the war when, owing to the failure of the company, operations were suspended. The coal used was from No. 4, or the Lower Kittaning, the same as is employed in the operations at Leetonia. The product of these ovens was sold for foundry purposes, and sent all over the state, and seemed to be satisfactory as to quality. A few thousand tons were sold to parties running a blast furnace at Martin's Ferry. With this exception none of it was used in blast furnaces.

Just before the failure of the Hammondsville Mining Co., Mr. W. H. Wallace built about a dozen ovens at Hammondsville, and continued to sell coke to within a year or two past. The vein, however, became too expensive to work and the effort was entirely abandoned.

The Steubenville Coal & Mining Co. are still making some coke. Operations commenced here in 1858, at first by coking the coal in ricks and subsequently in ovens. Slack, only, has been used in these ovens, as the object in view was to utilize the slack. There were origi-

nally some eighty-five ovens in use here, and at one time about 4,000 bushels of coke per day was manufactured. At present but ten ovens are working, and the daily product does not exceed 1,000 bushels, which is consumed by glass works and brick yards. Originally it was used in blast furnaces, and was shipped to Martin's Ferry and other river points for furnace consumption. The Steubenville furnace used this coke by itself in the manufacture of iron; making a foundry iron with about 100 bushels of coke to the ton of metal produced. It was afterwards used in the furnace mixed with Connelsville coke, and with the stoppage of this furnace, in 1868, the production of coke from these ovens dropped off and gradually fell away to their present output.

In 1862 Hon. John Hunter, of Alliance, purchased the Irondale property and built a furnace upon it. He also erected about forty bee-hive ovens and made coke for use in the furnace. Prof. Orton, in the last volume of the geological survey, calls the coal used here the Upper Freeport, but Mr. Hunter at the time supposed it to be No. 4, or Lower Kittaning. The coke product was used in the furnace mixed with Youghiogheny, in about equal parts, and the iron made, while not the best, was yet not of inferior quality. It is not supposed that the furnace could now be successfully operated upon native coke; the vein being but thirty inches thick, and too expensive to mine. The financial panic, which swept over the country in 1873, caused the furnace to be shut down the following year, and with it the coking operations ceased and have ever

since been suspended. Perhaps the largest coking operations at Steubenville were those of Messrs. Spaulding, Woodward & Co., and their successors, the Jefferson Iron Works. Their coking extended over a period of nineteen years, commencing in 1867, and ending in April, 1885. It is said that the first coke made at these works was in 1863, but no record was formed until 1867. The coal from the mine was screened and all but the large lumps was used for coking. The coke (made in bee-hive ovens) was very free from sulphur, but was soft and not able to bear much burden. The product was used in the company's blast furnace and made a very good mill iron. The number of ovens in use varied from time to time as did the coke product. Their largest production was in 1874, when 2,159,578 bushels of coke was made. At present there are 167 ovens standing, all of which are idle, and Connellsville coke is being used in the furnaces. Many reasons combined to bring about a discontinuance in the use of their own coke, which may be summed up in the fact that while under the old style of making iron the native coke was equal to the requirements of the trade, yet, owing to the rapid stride of modern improvements in smelting, its use became too costly and resource was had to foreign coke.

About 1873 extensive preparations were made for coking by the Mingo Iron Works, on the Ohio River below Steubenville. One hundred and twenty-five bee-hive ovens were at one time in operation here. In 1876 the daily product was about 3000 bushels, which amount gradually dwindled to

about 1000 bushels in 1879, and 600 bushels in 1883, when the enterprise was entirely abandoned. The coke was soft and high in ash and sulphur. It was used in the company's furnaces, causing them to work irregularly and was finally displaced by Connellsville as being cheaper per ton of iron made. Mr. George S. Dean, who was connected with the operation states, that relatively, as compared with Connellsville, it required one-third more native coke to the ton of metal, while the furnace out-put was one-third less. Other difficulties attended this experiment. The coal was of impure quality, and the vein thinned out until it became unprofitable to work it and comply with the provisions of the mining law.

COKING IN TUSCARAWAS COUNTY

Has received considerable attention in times past, but so far as known, is at present, entirely neglected. At Port Washington the coal of No. 6a was used with that of No. 6, but with this exception, the coking operations of the county were confined exclusively to the middle Kittanning or No. 6 vein.

In the year 1868 the Dover Furnace Company, of Canal Dover, erected two bee-hive ovens at Mineral Point where the middle Kittanning coal was coked for use in the furnace. The run of the mine was used, and the result was so satisfactory that in 1871 the company built eighteen ovens at Canal Dover and for some time afterward brought their coal from Mineral Point and coked it in these ovens. Its use was, however, shortly afterward discontinued, presumably from causes which produced the same result elsewhere.

From 1870 to 1873 Messrs. Samuel Foultz & Co. did some coking at Trenton, with No. 6 coal from the Walton Ridge mine. They built twenty bee-hive ovens and used slack and nut coal in them. Most of their product was shipped by canal and used by blast furnaces in Canada. The coke produced was soft and high in sulphur and the trade in it soon languished and became extinct.

Coking was carried on to some extent near Urichsville, from 1870 to 1881. Eight bee-hive ovens were in operation during that time. The coal used was from No. 6 or middle Kittaning, and the product was sold in Columbus, Cleveland and Chicago. The coke cemented nicely but contained too much sulphur for furnace use, and was sold mainly for domestic use and for foundry purposes. The best coke made was such as was coked for forty-eight hours, which is less time than has usually been found best with Ohio coals, the general verdict being in favor of fifty or seventy-two hour coke. It was rather soft in its nature, beside being burdened with sulphur. The run of the mine was used.

In 1883 a company of Scotch capitalists commenced extensive operations at Port Washington. Two blast furnaces were built with all the modern improvements, and the intention was to use the native coke and black band ore, in the expectation of producing an iron similar and equal to the celebrated Scotch pig. A large amount of capital was invested in the venture and experienced men were placed in charge.

In 1875 the company built three bee-hive ovens. The coal used in

these ovens was crushed and washed and was from veins Nos. 6 and 6a (lower Freeport). In 1877 the number of ovens was increased to sixty. From all accounts it seems to increase of capacity arose not so much from the success attending the working of the original ovens, as from a desire to impress the foreign stock-holders with the idea that their investment was prospering. From the start the coke was a failure and was never used by itself, but was mixed with Connelsville. Some of the ovens were never used and the native coke contained so much sulphur that the quality of iron produced did not warrant a continuance in its use. For this reason resort was had to Connelsville alone, by which an excellent quality of iron was made. Depression in the iron trade and other difficulties shortly after intervened and brought about the abandonment of the whole enterprise.

IN MUSKINGUM COUNTY

An effort was made to coke their coal, outside of the beaten track that has so far been considered.

At Zanesville in 1884, the Ohio Iron Company experimented in making coke from No. 6 vein to a considerable extent. Bee-hive ovens were at first used, but the result was not satisfactory and a resort was had to Belgian ovens and washed coal. These operations appear to have been conducted under the direction of one who was not competent for the undertaking. Twelve Belgian ovens were built, and the coal was crushed and washed before using. The washing apparatus was far from perfect and the result was that much sulphur

was left in the coal that might have otherwise been removed. Nevertheless the coke from the washed coal was much improved in purity as compared with that made from the unwashed. The ovens never reached the proper degree of heat for success. The manager removed the coke and recharged the ovens at irregular periods and without arriving at any just or proper idea of the time necessary to obtain the best results. Then again, he had but single doors to the ovens and they were not properly clayed up and made air tight. Numerous small leaks and many minor imperfections in the details of process, amounted in the aggregate to sufficient to defeat the object aimed at and to render their success incomplete. The coke contained much sulphur and was very soft and friable, and almost worthless for furnace use. Nevertheless Col Churchill, of the Ohio Iron Works, thinks that if the ovens had been properly managed the cementing would have been accomplished and a fair quality of coke produced. These experiments lasted about four months. Since then the ovens have been demolished and no further effort at coking has been made.

COSHOCTON COUNTY.

At Rock Run, in Coshocton county, commencing about 1869 and continuing until 1873, coke was made from the nut coal of the middle Kittanning or No. 6 vein. It was made in beehive ovens and used mostly for smelting purposes. When the small vein from which this coal was taken became worked out a new opening was made on the

same vein, but the coke made from the new opening was not saleable, consumers claiming it contained too much sulphur, and the enterprise was then abandoned. At Prossers mine, on the Ohio Canal, four miles south of Coshocton, some ovens were built and coke made, which was said to have been strong enough to bear a burden in a furnace, but it also contained so much sulphur as to interfere with its sale, and the manufacture was but short lived.

COKING IN THE HOCKING VALLEY

Has received but little attention, and, except some slight attempt by the XX Furnace, at Shawnee, the only effort in this direction worthy of remark has been made by the Nelsonville Coal & Coke Co., near Buchtel, in Athens county. This company was first formed with a view of making coal mining subordinate to the manufacture of coke. In 1880, twenty beehive ovens were erected, and are still standing. The coal used was from No. 7, or the Upper Freeport, and the largest product (about 1000 tons) was made during that year. Slack was used, and the result was a coke which, while soft, cemented fairly but only found sale for domestic purposes and for use in cupolas, owing to the amount of sulphur it contained. As the effort at coking was not successful, and gave but little encouragement to the operators, the manufacture gradually became less, and more attention was given to mining coal for sale, until, in 1885, at the close of the Hocking Valley strike, the ovens were shut down and coking was suspended. At present they are about to try crushing and washing

the coal, which, together with an improved oven, if successful, may result in a resumption of operations.

BELMONT COUNTY.

Some coking is being done at Flushing, Belmont county, and at other points on the C. L. & W. R'y. The most extensive of the plants is that of the Pittsburg & Wheeling Coal Co., near Bridgeport. Here 50 ovens were built, in 1882. The coal used is from the Pittsburg vein, and the coke is sold mainly for domestic use. It is soft and friable and does not cement well. Following in the steps of all similar ventures, in Ohio, the whole 50 ovens were worked full time at first, but the trade has dwindled until but 10 ovens are now in use.

VINTON COUNTY.

Perhaps the most thorough and extensive effort toward solving the problem of coke making in Ohio, occurred at the Vinton Furnace, in Vinton county, in 1875 and 1876. In 1874 and 1875, this furnace was running on Connellsville coke, using the native ores and making a most excellent quality of foundry iron. The depression in the iron trade, consequent upon the panic of 1873, made this fuel too expensive and the proprietors cast about for a cheaper fuel nearer home. Experiments were made in coking their coal in ricks, and in beehive ovens, all of which were unsatisfactory, owing to the dryness of the coal, which prevented its cementing and rendered it unfit to bear a burden in the furnace. Several veins of coal, upon the lands of the Vinton Iron & Coal Co., were tried, but the result in every case was the same. In the fall of 1875 it was

learned that coal, of a similar nature to the Vinton coal, was being washed and coked in Belgian ovens successfully, at Johnstown, Penn. Several cars of the Vinton coal (Brookville vein) were sent to Johnstown and treated by that process. The result was a bright, clear, compact coke, comparing favorably with Connellsville, and arrangements were at once entered into looking to the erection of a plant sufficient for the needs of the furnace, and upon the Johnston plan. An engine and crushing machinery was built, and a Bradford "Jig," or washer, was erected. The coal was crushed through a series of rollers to about the size of a pea and was then passed through the jig to remove the slate and sulphur. The jig was simply a flat trough working up and down in water. By its greater specific gravity the slate, sulphur and pyrites contained in the coal, sank to the bottom of the trough, while the pure coal passed out, over the top, into bins prepared for its reception. The completeness with which the slate and sulphur of the coal was eradicated, by this process, was simply marvelous and none but the sulphur which was a component part of the coal was left to be worked off in the coking.

Twenty Belgian ovens were erected, at a cost of \$750 each, and a pushing engine was provided, which ran on a track along the row of ovens, and by forcing a plunger through each oven, drove the whole mass (when ready) out upon the coke floor on the other side. The ovens were rectangular, being 22 feet long, 8 feet high and 28 inches wide, inside, with double door at each end. Between cinder, and

above each oven was a mass of hot air flues, by which means it was kept hot, and a high and equable temperature always maintained, by the burning gases which passed off through the flues. The ovens were charged from the top and, by an arrangement of wagons running over them, in connection with the discharge by the plunger, they could be emptied and recharged in very short order and without appreciable loss of heat.

The opening from which the coal coked at Johnstown came, was about three-fourths of a mile from the furnace. The ovens were erected on the hill near the top of the furnace, and a vein of coal (supposed to be the limestone vein) was discovered in close proximity to them which, upon opening at several points on the surface, proved to be a richer and better coal for coking purposes than that tried at Johnstown. The former vein was developed in preference to the latter, as being more economical in the matter of hauling, while the coal near the surface promised better results and appeared a better coal for treatment in the ovens. From this change of veins resulted the failure of the operation, as the limestone vein, when opened under the hill, was found to be in a series of faults and upheavals, which seriously affected the quality of the coal, and by the time the ovens were ready the product of the mine was a mass of niggerhead, sulphur and foreign material from which no satisfactory result could be expected. By this time the friends of the company were exhausted, nevertheless, as the problem to be solved was mainly the cementing of the coke and making it of suf-

ficient density to bear the furnace burden, it was determined to try this mass of dry rubbish in the ovens before throwing up the sponge. The ovens were run for about three weeks, and although at that time by no means up to the requisite temperature, yet the coke made, however inferior in quality otherwise, came out a hard, solid mass, in every way dense enough for furnace purposes. This was in January 1876, and it is said that this coke still lies on the coke floor almost in the shape in which it left the ovens, after an exposure of ten years to the action of the elements.

The result of this experiment made at a cost of about \$40,000 has demonstrated that by this means solidity can be obtained in coke made from Ohio coals, and the sulphur can be so reduced by washing the coal, together with the volatile sulphur that passes off in extinguishing the coke, as to be unobjectionable in the working of the furnace. The parties who made these experiments are still convinced that lack of funds alone prevented their going on to a successful solution of the question. A record was kept of the cost of coking, and although by no means at its minimum, owing to the ovens not being at their best nor any regular system adopted for working them, it was found that the whole expense attending it was about three-fourths of a cent per bushel and a bushel of coal made about the same amount of coke. The product, owing to the defective quality of the coal, was unfit for smelting purposes and made an inferior quality of mill iron. Had the original vein been used, instead of the one that was adopted, there is no doubt but the product would

have been equal to the coke made from it at Johnstown, and a success instead of a failure would have been the result.

Samples of coke were shown the writer in 1875, made in ricks, at Big Run, Athens county, from the Pittsburg vein, that were superior in weight, density and general appearance, to any he has yet seen made from Ohio coals. This coke was made as an experiment, by a farmer who was totally ignorant of the principles and requirements of

coking. This would seem to indicate that this vein could be successfully utilized, by skilled operatives as a coking coal, if not generally, at least, in this instance, locally; but as a general conclusion it may be safely assumed that the coals of Ohio, without the intervention of machinery and improved ovens, can never become successful competitors with those of Pennsylvania and the coking coals of West Virginia.
